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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:
G07D 5/08, G07F 3/02	A1	WO 93/02431
		(43) International Publication Date: 4 February 1993 (04.02.93)

(21) International Application Number: PCT/DK91/00209

(22) International Filing Date: 16 July 1991 (16.07.91)

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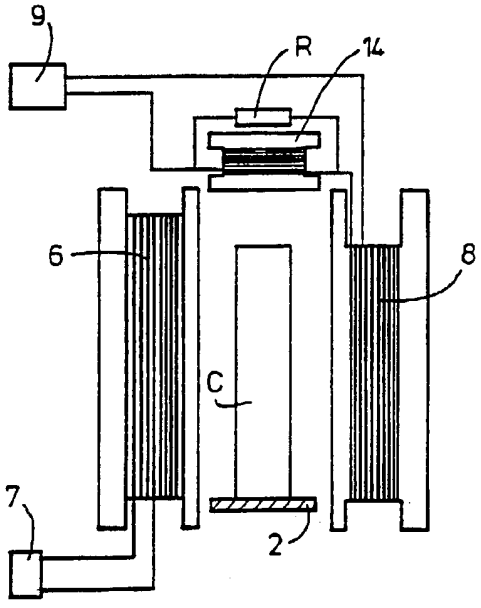
(81) Designated States: AT, AU, BB, BG, BR, CA, CH, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MC, MG, MW, NL, NO, PL, RO, SD, SE, SU, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LU, NL, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).

Published
With international search report.
In English translation (filed in Danish).

(54) Title: METHOD AND APPARATUS FOR TESTING AND OPTIONALLY SORTING COINS



(57) Abstract

In a coin testing apparatus of the type in which the coins are brought to pass an electromagnetic detection field this field is generated from a single coil (6), which is concurrently supplied with a high frequent signal (500 kHz) and two mutually different low frequent signals (10 and 30 kHz), whereby a high selectivity is achieved in a simple manner. The selectivity is further increased by completing the receiver coil (8) with a series connected auxiliary coil (14) mounted next to the space between the two main coils (6, 8) and having its electromagnetic axis extending into this space, this causing a highly increased sensitivity particularly for one of the low frequent signals (30 kHz).

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Method and apparatus for testing and optionally sorting coins.

The present invention relates to a method of detecting the kind or type of coins in a coin receiving apparatus in order to detect the coin values or to obtain a rejection of unacceptable coins or coin blanks. Such a detection is actual both in coin operated vending machines and in coin counting apparatuses, and there has been developed, long ago, mechanical sensing devices for testing the coin dimensions to thereby distinguish between current and unacceptable coins with a certain degree of accuracy. All according to the result of the detection the coins may then be accepted according to their denomination or be rejected as non-current.

It is also known that the test can be expanded to more than the size of the coins, viz. also to the coin metal alloy, it being relatively easy to test whether the alloy is 'correct', because coins of different alloys will have different shading effects towards induction signals sent across the coins between a transmitter and a receiver coil, e.g. with a frequency of 10-20 kHz. Already by an initial passage of the coins through such a detector it is possible to invoke a rejection of e.g. foreign coins, which, irrespective of their size, have a non-current alloy composition.

What will be left are such coins, the alloy of which is 'practically current' and also have sizes classifying them as 'practically current'. The diameter detection can be effected reasonably accurately by means of light sensors mounted in such a height over an inclined conveyor rail for the rolling coins that it is possible to distinguish between coins of respective

correct sizes and over- or , whereby there is provided a basis for an accept or a rejection of the passing coins.

It has been found, however, that such a detector system is not fully reliable, already because many truly current coins are smudged to such a degree that there is dirt also on the coin periphery, whereby the coins will reveal themselves with an increased diameter, when the latter, as usual, is measured between a support for the rolling coins and the upper coin edge. For one thing, the coins may be slightly elevated from the support due to the dirt on their periphery, and for another thing the photometrically measured position of the top edge of the coin may be still further elevated due to dirt on this edge portion. There are non-current types of coins which may hereby be accepted as current, also when subjected to the alloy test.

From US-A-4,124,111 a detector system is known, in which the coins are caused to roll or fall through three intercoupled coils forming a differential transformer that is fed, in an alternating manner, by a 'low' frequency, viz. 200 kHz, and a 'high' frequency, viz. 1 MHz, whereby it is possible, based on the differential signal from the two consecutive, secondary windings, to process the measured maxima and thereby find different characteristic signal combinations for different types of coins. Such a system is usable for selective detection of mutually very different types of coins, but it is in no way sensitive enough for a detection or rejection of coin types only slightly deviating from acceptable types.

An improved detector system from the same manufacturer is disclosed in US-A-4,108,296. Here is used three sets of coils mounted in a successive manner along a rolling path for the coins, one coil set consisting of a transmitter coil at one side of the

rolling path and a receiver coil at the other side, this being sufficient for a detection of the coin diameter. The other two coil sets are still made as triple coil differential transformers, but here mounted in the same manner as the first coil set, i.e. with a primary coil and one of the secondary coils mounted at one side of the rolling path and with the other secondary coil mounted at the other side thereof. These two sets of coils operate with mutually different frequencies of non-specified values for the detection of the character of the coin material and the coin surface, respectively. There is no sufficient basis for an evaluation of the sensibility of this system, but at least it is a complication that a relatively high number of coils with associated detector means is required.

In connection with the invention it has been recognized that it is perfectly possible to make use of only a single set of coils mounted like the first coil set mentioned in the above account of US-A-4,108,296, when the transmitter coil is supplied with more different frequencies at the same time. These different frequency signals will be received, more or less attenuated, by the receiver coil, but on the receiver side it is easy to detect how much the single frequency signals are attenuated at maximum by the passage of the single coins, and based on these measurements it is possible to determine very accurately whether a given coin is current and, if so, what its value is.

The measuring results for more different frequencies will then be at disposal concurrently for the data processing, and with a suitable choice of frequencies it can be rapidly and accurately determined whether the coin is current and what its nominal value is. The different coins will reveal themselves by quite specific combinations of the measuring results of the different frequencies, and already by the concurrent use

of three different frequencies in the sole coil set a rapid and reasonably accurate selection will be made possible.

It should be emphasized that the invention preferably calls for frequencies that are substantially deviating from the above mentioned frequencies in the described known system, as for the diameter detection it has been found sufficient to operate at some 500 kHz, while for the detection of the alloy and the thickness it has been found suitable to apply frequencies as low as 10 and 30 kHz. It has been found that in particular the intermediate frequency of approximately 30 kHz is highly significant for a very accurate detection of the coin.

In connection with the invention it has furthermore been found that a significant improvement is achievable by addition of a third coil in quite another plane, viz. with an axial direction coinciding with the plane of the passing coins, i.e. a coil placed above or beneath the rolling path of the coins. In a partly inexplainable manner it is possible to hereby obtain extra characterizing measuring data, which are surprisingly selective both at the 'high frequency' 500 kHz and still more at the intermediate frequency 30 kHz. The result is a previously unknown sensitivity and efficiency with respect to a distinguishing between different coin types, which may otherwise produce mutually mistakable measuring results. It is seldom a problem to detect different current coins, as in the single countries care it has been ascertained in advance that the various kinds of coins are suitably different, but for each country there will be certain foreign coin types which, when tested electronically, will produce almost the same result as a current coin, and particularly in these cases the said third coil has been found extraordinary useful, because it is surprisingly selective

particularly at the intermediate frequency 30 kHz.

If a non-current coin is detected hereby, this fact or result may be used to provide to the coin conveying means a signal for immediate rejection of the coin to a collector tray for non-current coins once the coin has left the field sensing station, while current coins are allowed to be conveyed further to a more or less conventional sorter station. The sorting out may be effected conventionally by purely mechanical diverter means for coins of different characteristic diameters, but an associated summing up of the coin values man be effected in or by the said detector unit, in which the current coins are fully identified.

According to the invention, however, it will be a further possibility that based on the coin detection selective control signals may be applied to diverter means located along a downwardly inclined rolling path of the coins in such a manner that the coins, without any further diameter detection, are thrown off from the rolling path at the relevant places thereof for collection in respective containers or trays.

In the following the invention is described in more detail with reference to the drawing, in which

Fig. 1 is a perspective view of a detector and sorter unit according to the invention,

Fig. 2 is a lateral view thereof,

Fig. 3 is a perspective view of a modified embodiment of the invention, and

Fig. 4 is an end view thereof. The structure shown in the drawing is based on the use of a downwardly inclined roller rail 2, to the upper end of which there is successively supplied coins from a non-illustrated, but well known coin supply unit. The coins roll down along the rail 2 in a suitably side supported manner, and they will hereby pass through a sensor station comprising a U-shaped carrier member 4 for a transmitter

coil 6 at one side of the rolling path and a receiver coil 8 at the opposite side of this path. Both of these coils are marked high and narrow, such that they will be slightly higher than the largest current coin and well narrower than the smallest current coin.

From a generator 7 the transmitter coil 6 is supplied with three different frequency signals, viz. of 10, 30 and 500 kHz, respectively, and by the running-through of the coins through the unit 4 the induction signal received by the receiver coil 8 will be subjected to a certain attenuation, which can be detected by an associated, non-illustrated receiver and detector unit 9, in which each one of the three signals are detected. The attenuation of the frequencies 10 and 30 kHz will depend mainly of the alloy of which the passing coin consists, while the attenuation of the frequency 500 kHz will mainly depend of the coin area that acts shadowing between the two opposed coils. During the rolling-through of the single coins this area will increase to and decrease from a maximum corresponding to the coin diameter, and in the receiver unit it will be easy to detect the maximum attenuation, which will thus be indicative of the diameter of the coin.

With the use of a suitably sensitive electronic circuit it is possible to obtain a highly sensitive detection of both the coin alloy and the coin diameter, an thus it will be unimportant whether the coin is more or less smudged, as usual dirt will seldom affect the field attenuation noticeably. For the detection of the "maximum diameter", therefore, it will be quite unimportant whether the rolling coin, due to dirt, is more or less raised from the rolling rail 2, which would otherwise, by a photometric measurement, give ride to a wrong result.

In Fig. 1 it is shown that immediately behind the

unit 4 there may be provided a rejector unit 10, which, by means of a piston 12, is operable to push out any passing coin to a collector tray for non-current coins, viz. in response to a non-current coin having been detected by its passage through the unit 4. The current coins are allowed to continue their rolling down along the rail, whereby they can be diverted, conventionally, to different collector trays all according to their diameters, this being arrangeable in a purely mechanical manner as already known.

In connection with the invention, however, it will be an advantageous possibility that instead of mechanical diverter means there may be used e.g. electromagnetically operated rejector means placed along the rolling rail so as to be actuatable at respective correct moments of time relatively to the size detection of the coin by the passage thereof through the unit 4, such that the mechanical diverter means can be entirely avoided.

In this connection it may be required to arrange for sensors for sensing the ordinary progress of the coin rolling so that it can be ensured that an actuation signal for a given rejector unit will really refer to the relevant coin, e.g. after a non-current coin having been rejected by means of the unit 10,12. Such a detection of the coin movement is easy to provide, e.g. by placing cross radiating light diodes at different places along the rolling path 2.

The smudge present on the coins may, over the time, be deposited on the inner sides of the unit 4, whereby an unintended, general attenuation of the induction signals between the coils 6 and 8 may occur and give rise to detection errors. This calamity, however, may be counteracted in a simple manner by way of the associated electronic control and detector unit being made self-calibrating when no actual throughrunning of coins

take place, this condition being detectable by this unit itself. When the received signal on the coin 8 is stable through a certain period of time there will be no coin on its way through the unit, and the unit may then be selfadjusting such that the received signal for each of the three frequencies gives rise to a preset "zero result", which will ensure a correct calibration of the equipment. The calibration will not have to be made consequently between all coin passages, but e.g. only at larger time intervals, as a noticeable smudging of the unit 4 will seldom occur all by a sudden.

The embodiment shown in Figs. 3 and 4 is characteristic by having at its top an additional coil 14, the coil axis of which extends down along the planes of the coils 6 and 8. According to Fig. 4 this additional coil is connected in series with the receiver coil 8, which is here made with a hight somewhat smaller than the height of the transmitter coil 6; if these two coils are of equal height the effect on the coil 14 will be insufficient. As mentioned, it has been found that the addition of the coil 14 results in a highly increased sensibility.

In practice it has been found suitable to use a transmitter coil 6 with a height of 33 mm and a receiver coil 8 with a height of 28 mm. Coins of a diameter above 28 mm will, the produce identical measuring results as far as the high frequency 500 kHz is concerned, but this is more than counterbalanced by the increased sensibility at the intermediate frequency 30 kHz, whereby a clear distinguishing can be obtained between coins that are only slightly different. The current coins are very different and are sharply definable by associated sets of measuring valves, and particularly with the use of the coil 14 these acceptable valve sets themselves may be defined so sharply that even quite small deviations with respect to size, thickness and

alloy composition will be detectable.

By way of example, the coils 6 and 8 may have 160 windings with 0,25 mm coppar wire, while the coil 14 may have 120 windings with 0,10 mm coppar wire. Preferably a shunt resistance R of e.g. 100 Ohms is mounted across the coil 14.

It is important that the coils 8 and 14 be correctly connected, in practice in that the series connection is established between the coil wire ends located adjacent to the measuring area. The transmitter coil 6 would need to be driven with increased effect if the coil 14 is not used.

Preferably, the system is designed such that it can be switched into a self calibration mode, in which it will detect the measuring values for known coins, whereafter, with the use of suitable adjustment means, the system can be adjusted to such deviations, which will be acceptable in practice. Otherwise the adjustment may be so fine that it will be possible to distinguish between new and only slightly worn coins. The system, by itself, may registrate the relevant area of variation for the single coin types, if the calibration is effected based on a larger number of both new and used coins.

It will be possible to distinguish between quite many different coins already at the basis of the measuring values for a high frequent signal and only one low frequent signal, but situations of coincioling measuring results may occur, whereby it is important that use is made of a further, low frequent signal. The frequencies are not particularly critical, but preferably the two low frequent signals should be below 100 kHz and be separated by at least 10 kHz, while the high frequent signal should be well above 100 kHz. However, no special effect is obtained by raising this frequency to more than 500 kHz.

C L A I M S:

1. A method of detecting the kind or type of coins in a coin receiving or sorting apparatus, whereby the coins are brought to pass through an electromagnetic detection field, the attenuation of which by such a passage being measured for signals in a higher and a lower frequency area, respectively, characterized in that the detection field is produced by applying to a single transmitter coil concurrently a high frequent signal of more than 100 kHz and two low frequent signals of below 100 kHz and with a mutual separation of at least 10 kHz, preferably of approximately 10 and 30 kHz, respectively, these signals being selectively detected at the receiver side of the system.

2. An apparatus for carrying out the method according to claim 1, having a rolling or falling path for coins, a transmitter coil arranged at one side of this path and a receiver coil arranged at the other side thereof, and having means for energizing the transmitter coil and for detecting the signal of the receiver coil in connection with each ocurring coin passage, characterized in that the power supply means comprise generator means for simultaneous feeding to the transmitter coil one high frequent and at least two, mutually different low frequent signals, the detector means correspondingly being adapted to selectively detect these respective signals from the receiver coil.

3. An apparatus according to claim 1, in which the receiver coil is completed with an auxiliary coil located next to the space between the transmitter coil and the receiver coil and oriented with its axis

extending through this space.

4. An apparatus according to claim 3, in which the receiver coil is of reduced extension relative to the transmitter coil out the place where the auxiliary coil is mounted.

5. An apparatus according to claim 2, in which the control unit is so adapted that in response to acceptance of a current coin it will cause a selective diversion of the coin to a collector means at a relevant place of the conveying path of the coin, independant of a mechanical sensing of the coin diameter.

6. An apparatus according to claim 2, in which the detector and electronic unit is self-calibrating in that in periods with no detected coin passage it will adjust itself to a correct zero setting.

7. An apparatus according to claim 2, characterized in being switchable into a self-calibrating mode, in which the measuring results for known types of coins passed through the measuring area are read into a memory unit.

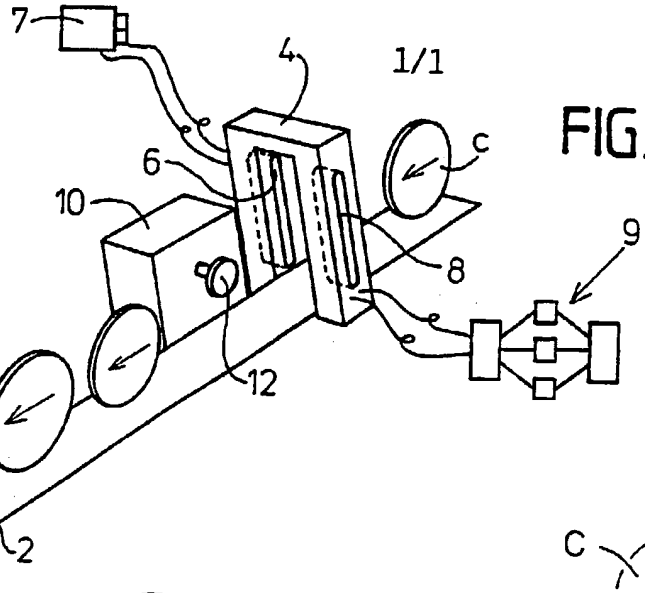

FIG. 1.

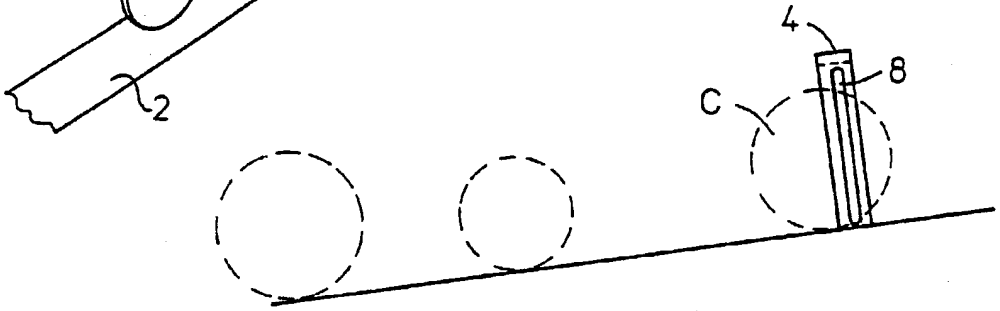

FIG. 2.

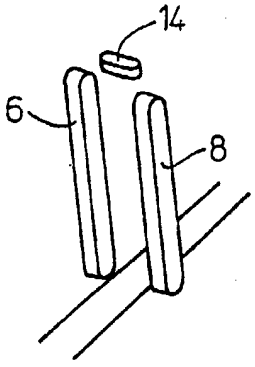

FIG. 3.

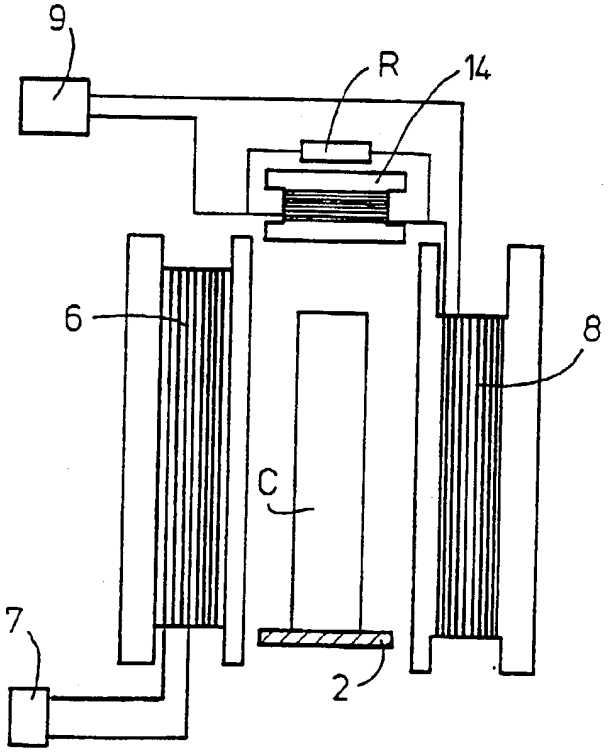

FIG. 4.

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK 91/00209

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: G 07 D 5/08, G 07 F 3/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	G 01 B, G 07 D, G 07 F

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
Y	US, A, 3918563 (G. SCHWIPPERT ET AL) 11 November 1975, see column 1, line 31 - line 66; abstract; claim 1 --	1,2,5-7
Y	GB, A, 2164188 (SODECO-SAIA AG) 12 March 1986, see page 1, line 53 - line 62; page 1, line 127 - page 2, line 7; page 2, line 63 - line 79; page 2, line 101 - line 115; abstract; claim 1 --	1,2,5-7
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
6th September 1991	1991 -10- 16
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	LARS JAKOBSSON

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A	GB, A, 1362628 (INTERNATIONAL STANDARD ELECTRIC CORPORATION) 7 August 1974, see claim 1 --	3
A	US, A, 4124111 (Y. HAYASHI) 7 November 1978, see column 1, line 26 - column 2, line 4; column 2, line 51 - column 3, line 9; claim 1 --	1-3
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		FR-A- 2138900	73-01-05
		GB-A- 1397083	75-06-11
		LU-A- 65410	72-08-23
		NL-A- 7207010	72-11-28
		SE-B-C- 393475	77-05-09
		US-A- 3870137	75-03-11